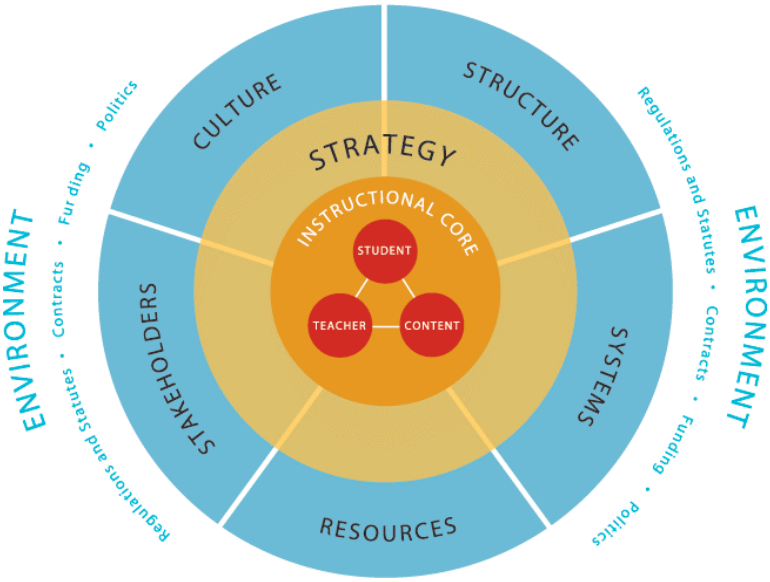
Characteristics of High Quality Teaching and Learning in Kentucky Schools

This document is an effort to describe the roles of the teacher and student in an exemplary science/mathematics instructional environment. The focus of the document is on the "instructional core" at the center of the educational process as described in detail in the *Public Education Leadership Program (PELP)* www.hbs.edu/pelp. Future documents will address the "outer ring" factors that are present in science classrooms in high achieving schools and districts – essential resources for science programs, stakeholder involvement, the learning culture, structures and system components, including sustained high quality professional learning opportunities for teachers who are at the core of the instructional process.

PELP Coherence Framework



Note: The research document citations present in the original version have been removed for the purpose of focusing on the characteristics statements themselves. These documents, based on research, articulate the vision for high quality science instruction and have also served as the basis for additional and more current research. Therefore, they should be considered in their entirety as the underlying basis for all of the topics listed.

- **National Research Council (NRC). (1996). *National Science Education Standards*. Washington, DC: National Academy Press.**

- **National Research Council (NRC). (2000). *Inquiry and the National Science Education Standards*. Washington, DC: National Academy Press**
- **National Research Council (NRC). (2001). *Classroom Assessment and the National Science Standards.* Washington, DC: National Academy Press**

In addition, the following state documents provide the framework and guidance for all science instruction in Kentucky:

- **Program of Studies, Revised 2006**
- **Academic Expectations**
- **Core Content for Assessment, Version 4.1**

Science

1. Knowledge of Content

The teacher:

- A. Demonstrates an understanding of the science content in the grades/courses assigned, and an ability to convey this content to students.
- B. Keeps abreast of current developments in the sciences
- C. Designs standards-based courses/lessons/units using *Kentucky's Program of Studies* Revised 2006, *Academic Expectations*, and *Core Content for Assessment Version 4.1.*
- D. Demonstrates proficiency in the use of measurement and data collection tools and techniques to gather, manage, analyze, and interpret data; including computer-based measurement devices, modeling tools and instructional supports to enhance student learning opportunities.
- E. Uses and promotes the understanding of appropriate scientific vocabulary
- F. Provides essential supports for students in science who are learning English or have limited English proficiency
- G. Accesses a rich repertoire of instructional practices/strategies and applies them appropriately to the particular needs of his/her students aligned with the cognitive demand of the science content (pedagogical content knowledge).

The student:

- H. Uses and seeks to expand appropriate scientific vocabulary
- I. Connects science ideas in different content strands, (Physical, Life, and Earth/space), and in different content areas
- J. Uses science ideas in realistic problems

2. Instructional Rigor and Student Engagement

The teacher:

- A. Teaches the complex processes, concepts and principles contained in the *Kentucky Core Content for Science,Version 4.1* and the *Program of Studies, Revised 2006* using differentiated strategies that make them accessible to all students
- B. Scaffolds instruction to help students reason and develop problem-solving strategies
- C. Consistently demonstrates proficiency with the use of appropriate tools, technology and techniques to solve problems
- D. Provides opportunities for and encourages students to connect multiple representations of scientific ideas, such as pictures, written explanations, symbolic work, diagrams, manipulative models, etc.
- E. Engineers effective classroom discussions, questioning, and learning tasks that promote higher-order thinking skills
- F. Challenges students to think deeply about problems and encourages/models a variety of approaches to a solution
- G. Integrates a variety of learning resources with classroom instruction to increase learning options for all students; these should include guest presenters, field experiences, and career explorations.
- H. Structures and facilitates ongoing formal and informal discussions based on a shared understanding of rules of scientific discourse
- I. Integrates the application of inquiry skills into learning experiences
- J. Clarifies and shares with students learning intentions/targets and criteria for success.

The student:

- K. Articulates and understands learning intentions/targets and criteria for success
- L. Reads with understanding a variety of informational science texts (articles in popular press, textbooks, non-fiction books, Internet, etc.)
- M. Applies and refines inquiry skills by:
    - a. asking and identifying questions and concepts to guide scientific

investigations
- b. designing and conducting scientific investigations
- c. using appropriate technology and mathematics to enhance investigations/problem solving (science probes, graphing calculators, spreadsheets)
- d. formulating and revising explanations and models
- e. analyzing alternative explanations and models
- f. collaborating with other scientists/students
- g. accurately and effectively communicating results and responding appropriately to critical comments
- h. generating additional testable questions

3. Instructional Relevance

The Teacher:

- A. Designs lessons that allow students to participate in empowering activities in which they understand that learning is a process and mistakes are a natural part of the learning
- B. Links concepts and key ideas to students' prior experiences and understandings, uses multiple representations, examples and explanations
- C. Incorporates student experiences, interests and real-life situations in instruction
- D. Possesses an understanding of a variety of technology appropriate to the content area, e.g. computer-assisted instruction, CBLs and probes for data collection, scientific and graphing calculators for middle/high school
- E. Effectively incorporates technology that prepares students to meet future challenges, as articulated by the **Partnership for 21st Century Skills.**
- F. Works with other teachers to make connections between and among disciplines to show how science is a part of other major subjects

The student:

- G. Responds to and *poses* non-trivial questions
- H. Uses appropriate tools and techniques to gather, analyze, and interpret quantitative and qualitative data
- I. Explores scientific issues underlying national and local decisions and expresses positions (in speech and writing) that are scientifically and technologically informed
- J. Designs and conducts scientific investigations, and uses the results to make real-world applications and generate further questions.
- K. Recognizes and analyzes alternative explanations and predictions
- L. Thinks critically and logically to identify the relationships between evidence and explanations
- M. Develops descriptions, explanation, predictions, and models using evidence
- N. Poses and evaluates models/arguments based on evidence and apply

conclusions from such models/arguments

- O. Describes, explains and predicts natural phenomena
- P. Communicates scientific procedures and explanations using appropriate scientific vocabulary
- Q. Exhibits skills, attitudes, and values associated with scientific inquiry
- R. Evaluates the quality and accuracy of scientific information on the basis of its source and the methods used to generate it.
- S. Works collaboratively to address complex, authentic problems which require innovative and/or creative approaches to solve
- T. Communicates science concepts in a variety of real-world forms (e.g., multimedia, transactive writing, computer modeling, etc.)
- U. Communicates science concepts for a variety of purposes (e.g., facilitating collaboration, persuasion, dissemination of information, formative & summative assessment, etc.)

4. Learning Climate

The teacher:

- A. Creates learning environments where students are active participants in creating, questioning, sharing, discussing, reasoning and analyzing the processes involved in solving scientific problems/tasks
- B. Motivates students to achieve, and nurtures their desire to learn in an environment that promotes empathy, compassion, and a mutual respect both among students and between students and the teacher
- C. Encourages students to accept responsibility for their own learning and respects the right of each student to ask questions and to request resources to more fully understand, enhance, or add clarity to the learning
- D. Provides learning experiences that actively engage all students as individuals and as members of collaborative groups
- E. Displays effective and efficient classroom management (e.g., in facilitating cooperative groups, in use of equipment or hands-on materials)
- F. Provides sufficient time in science class for students to engage in hands-on experiences and to make connections with these experiences and scientific principles.

The student:

- G. Accepts responsibility for his/her own learning
- H. Actively participates and is authentically engaged (vs. merely compliant)
- I. Collaborates/teams with other students
- J. Exhibits a sense of accomplishment and confidence.
- K. Takes educational risks in class (to refute, defend, etc.)

5. Classroom Assessment and Reflection

The teacher:

- A. Uses multiple methods and systematically gathers data about student understanding and ability (formative and summative assessments)
- B. Uses student work/data, observations of instruction, assignments and interactions with colleagues to reflect on and improve teaching practice

- C. Revises instructional strategies based upon student achievement data (short term and long term)
- D. Uncovers students' prior conceptions about the concepts to be addressed and addresses students' misconceptions/incomplete conceptions
- E. Co-develops scoring guides/rubrics with students and provides adequate modeling to make clear the expectations for quality performance
- F. Guides students to apply rubrics to assess their performance and identify improvement strategies
- G. Provides regular and timely feedback to students and parents (focused, descriptive, qualitative) that moves learners forward
- H. Allows students to use feedback to improve their work before a grade is assigned
- I. Facilitates students in self- and peer-assessment
- J. Reflects on work and makes adjustments as learning occurs

The student:

- K. Recognizes what proficient work looks like and determines steps necessary for improving his/her work
- L. Develops and/or uses scoring guides periodically to assess his/her own work or that of peers
- M. Uses teacher feedback to improve his/her work
- N. Reflects on work and makes adjustments as learning occurs

Reference Resources

The Partnership for 21st Century Skills: Learning for the 21st Century
http://www.21stcenturyskills.org/index.php?option=com_content&task=view&id=29&Itemid=42

The Science Program Improvement Review (National Science Teachers Association) - Vision and Expectations

http://www.nsta.org/about/initiatives/spir/vision.aspxhttp://www.nsta.org/about/initiatives/spir/

National Science Education Standards (National Research Council, 1996)
http://www.nap.edu/readingroom/books/nses/

“Rigor on Trial” by Tony Wagner (Harvard University)
http://www.gse.harvard.edu/clg/pdfs/rigorontrialedweek.pdf

How Students Learn Science in the Classroom
http://www.nap.edu/catalog/11102.html#toc

Kentucky’s Program of Studies, Revised 2006: Science
http://education.ky.gov/KDE/Instructional+Resources/Curriculum+Documents+and+Resources/Program+of+Studies/defaulthtm

National Science Teachers Association: Official Positions
http://www.nsta.org/about/positions.aspx